PATENT SPECIFICATION

904,887

Inventor: SIDNEY ALLEN.

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International Classification:—F02k.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Metal Tube for Forming Part of a Wall of a Combustion Chamber

WE, BRISTOL SIDDELEY ENGINES LIMITED, a British Company, of Stonebridge House, Colston Avenue, Bristol, 1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a combustion chamber (e.g., a rocket motor) of the kind built up from a plurality of metal tubes which are bent to the required longitudinal shape and are arranged side-by-side, with flat side walls abutting those of the neighbouring tubes, and permanently secured together, as by welding; the interiors of the tubes serving for the circulation of a coolant. With such a combustion chamber, particularly when it forms a rocket motor, or otherwise must withstand a high internal pressure, the tubes must be formed from such a metal and be of such a wall-thickness that they will provide the necessary strength. It is also the case, particularly where the combustion chamber is of varying cross-sectional area (e.g., as with a rocket motor), that a throat portion is formed which will tend to reach an undesirably higher temperature than other portions of the combustion chamber and will, consequently, require more cooling. The object of the invention is to meet these conditions.

According to the invention, a constituent tube, of a combustion chamber of the kind set forth, has the wall which will be presented inwardly made to have a higher degree of heat-transference, than other regions of the tube, in a region which will tend to become over-heated during operation of the combustion chamber.

Thus, according to one feature of the invention, the tube has a less wall-thickness in the said region; whilst according to another feature the said region is formed from another metal having a higher heat-transference characteristic than the metal of the remainder of the tube.

In the case where the higher degree of heat-transference is provided by reducing the wall-thickness, that can be done either by thinning the wall at the side of the tube which will be presented to the inside of the combustion chamber, or by completely removing that portion of the wall and substituting it by an insert, of the same metal but thinner, sealingly secured (e.g., by welding) to the edge of the hole thus formed; while in the case where the higher degree of heat-transference is provided by forming the said region of the tube from another metal, the portion of the tube which will be presented to the interior of the combustion chamber is removed and a correspondingly shaped insert of the metal having the higher heat-transference characteristic is sealingly secured (e.g., by welding) to the edge of the hole thus formed. When the insert is thinner than the remainder of the tube wall the edges of the insert, which may be a stamping, may be made equal to the thickness of the tube wall at the edge of the hole so as to facilitate welding it into position.

According to a further feature, and in the case where the tube is to have its wall-thickness reduced in the said region, the invention includes the method of making the tube which includes starting with a straight tube of uniform wall-thickness, and removing some of the metal from the wall in the said region before bending and forming the tube to its final shape.

According to yet another feature, and in

[Price 4s. 6d.]

the case where the tube is to have an insert in the said region, the invention includes the method of making the tube which includes starting with a straight tube of uniform wall-thickness, removing the wall in the said region, and sealingly closing the opening thus formed in the tube wall with an insert, either of the same metal but thinner, or of a metal having a higher heat-transference characteristic, before bending and forming the tube to its final shape.

The tube is preferably made in the manner in which an initially straight tube is first bent to the required longitudinal shape and is then pressed simultaneously in two directions at right-angles to each other to invest it with a substantially truncated-wedge-shaped cross-section such as will enable it to be assembled side-by-side with a plurality of identical tubes to form the combustion chamber. When the tube of the present invention is to be made in this way it will be of a metal (e.g. stainless steel) which can withstand the deformation without detriment to the final tube, and it is preferred for the wall-thickness of the aforesaid region to be reduced, or for the aforesaid region to be provided by an insert, while the tube is straight. By using stainless steel as the material for the tubes, the latter can very conveniently be connected together, after assembly, by welding.

In the case where the aforesaid region is to be provided by an insert, it is preferred for nickel to be used for the purpose (but it will be understood that other suitable metals could be used instead), and the insert can be annealed if necessary before the pressing operation is effected.

In the accompanying drawings:—

Figure 1 is a side view of a tube, of circular cross-section and in the preliminary straight condition, having the region which will tend to become over-heated formed as an insert of a metal having a higher heat-transference characteristic than the metal of the remainder of the tube;

Figure 2 is a side view of the tube of Figure 1 after it has been bent longitudinally, and has had its cross-section modified to enable it to be assembled side-by-side with a plurality of identical tubes to form the wall, of varying, substantially circular cross-section, of a rocket combustion chamber;

Figure 3 is a reproduction to a larger scale of a central portion of Figure 2 but showing a modification;

Figures 4 to 9 inclusive are cross-sections, to a uniformly enlarged scale, on the lines denominated by the same numerals in Figure 2;

Figure 10 is a view similar to Figure 1 excepting that the region tending to become over-heated has its heat-transference increased by reducing the wall-thickness;

Figure 11 is a view similar to Figure 2 but corresponding with Figure 10, and

Figure 12 is a cross-section, to an enlarged scale, on the line 12-12 of Figure 11.

Referring to Figure 1, the tube 20, of circular cross-section, is of stainless steel and has had a portion at one side removed (e.g., by milling right through the wall) and replaced by an insert 21 of nickel which has been welded in position. The tube is then bent to the longitudinal shape shown in Figure 2, and then pressed simultaneously in two directions at right-angles to each other to invest it with a substantially truncated-wedge-shaped cross-section, which varies at different positions along the tube, such as will enable it to be assembled in flat side-by-side relationship with a plurality of identical tubes to form a rocket combusion chamber wall of substantially circular cross-section.

Figures 4 to 9 inclusive, indicating the changes in cross-sectional shape of the tube of Figure 2, show the stainless steel tube at 20 and the nickel insert at 21, the edges of the insert being butt welded to the edges formed by the milling operation.

Instead of the insert 21 being of nickel it can be of the same metal as the tube but thinner, and in such a case, or when the isert is of another metal and its thickness is less than the tube wall-thickness, the insert margin can be thickened to make it equal to the tube wall-thickness so as to improve the weld as shown in Figure 3.

The insert 21, when of the same thickness as the tube, can either be cut out from a flat sheet and be bent transversely to the required form, or be cut from a tube of the same diameter as the tube 20, while in the case where it is thinner than the tube wall and has a thickened edge it can be formed as a stamping.

Referring now to Figure 10 the stainless steel tube 20*a* shown is again of circular cross-section, but for increasing heat-transference in the desired position its wall-thickness is reduced from the outside in the region of which one symmetrical half 21*a* is defined by the dotted line 22 and of which the other half lies behind that shown. The tube is then bent to the longitudinal shape shown in Figure 11 and then pressed simultaneously in two directions at right-angles to each other as described with reference to the construction shown in Figures 4 to 9.

It is the left-hand side of the bent tubes shown in Figures 2, 3 and 11 which will form part of the inner wall of the rocket combustion chamber, the straight portions 23 shown at the tops of these Figures be-

ing for forming a cylindrical portion of the said chamber, the bottom portions 24 being for forming a divergent nozzle portion of the said chamber, and the intermediate curved portion being for providing a throat in the said chamber. It is obviously in this throat that the highest gas temperatures will be encountered, and the tubes therefore have their heat-transference enhanced, by the means of the invention, in this region to facilitate the cooling of the throat by the coolant passing through the tubes.

WHAT WE CLAIM IS:—

1. A constituent tube, of a combustion chamber of the kind set forth, of which the wall that will be presented inwardly is made to have a higher degree of heat-transference in a region which will tend to become over-heated during operation of the combustion chamber.

2. A tube, according to Claim 1, in which, for increasing the degree of heat-transference in the said region, the wall-thickness in the said region is made less.

3. A tube, according to Claim 1 or 2, in which, for increasing the degree of heat-transference in the said region, the wall in the said region is formed from a metal having a higher heat-transference characteristic than the metal of the remainder of the tube.

4. The method of making a tube according to Claim 2 which includes starting with a straight tube of uniform wall-thickness, and removing some of the metal from the wall in the said region before bending and forming the tube to its final shape.

5. The method of making a tube according to Claim 2 which includes starting with a straight tube of uniform wall-thickness, removing the wall in the said region, and sealingly closing the opening thus formed in the tube wall with an insert of the same metal, but thinner, before bending and forming the tube to its final shape.

6. The method of making a tube according to Claim 3 which includes starting with a straight tube of uniform wall-thickness, removing the wall in the said region, and sealingly closing the opening thus formed in the tube wall with an insert of a metal having a higher heat-transference characteristic before bending and forming the tube to its final shape.

7. A constituent tube, of a combustion chamber of the kind set forth, substantially as described with reference to Figures 1, 2 and 4 to 9 of the accompanying drawings.

8. A constituent tube, of a combustion chamber of the kind set forth, substantially as described with reference to Figure 3 of the accompanying drawings.

9. A constituent tube, of a combustion chamber of the kind set forth, substantially as described with reference to Figures 10 to 12 of the accompanying drawings.

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PROVISIONAL SPECIFICATION

Metal Tube for Forming Part of a Wall of a Combustion Chamber

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The invention relates to a combustion chamber (e.g., a rocket motor) of the kind built up from a plurality of metal tubes which are bent to the required longitudinal shape and are arranged side-by-side, with flat side walls abutting those of the neighbouring tubes, and permanently secured together, as by welding, the interiors of the tubes serving for the circulation of a coolant. With such a combustion chamber, particularly when it forms a rocket motor, or otherwise must withstand a high internal pressure, the tubes must be formed from such a metal and be of such a wall thickness that they will provide the necessary strength. It is also the case, particularly where the combustion chamber is of varying cross-sectional area (e.g., as with a rocket motor), that a throat portion is formed which will tend to reach an undesirably higher temperature than other portions of the combustion chamber and will, consequently, require more cooling. The object of the invention is to meet these conditions.

According to the invention, the region, which will tend to become over-heated, of a constituent tube of a combustion chamber of the kind set forth, is made to have a higher degree of heat-transference than other regions of the tube.

Thus, according to one feature of the invention, the tube has a reduced wall-thickness in the said region; whilst according to an alternative feature the said region is formed from another metal having a higher heat-transference characteristic than the metal of the remainder of the tube.

In the case where the higher degree of heat-transference is provided by reducing the wall thickness, that can be done either internally or externally at the side of the tube which will be presented to the inside of the combustion chamber; while in the case where the higher degree of heat-transference is provided by forming the said region of the tube from another metal, the portion of the tube which will be presented to the interior of the combustion chamber is removed and a correspondingly shaped insert of the metal having the higher heat-transference characteristic is sealingly secured (e.g., by welding) to the edge of the hole thus formed. The thickness of the edges of the insert, which may be a stamping, may be made equal to the edge of the hole so as to facilitate welding it into position.

The tube is preferably made in the manner in which an initially straight tube is first bent to the required longitudinal shape and is then pressed simultaneously in two directions at right-angles to each other to invest it with a substantially truncated-wedge-shaped cross-section such as will enable it to be assembled side-by-side with a plurality of identical tubes to form the combustion chamber. When the tube of the present invention is to be made in this way it will be of a metal (e.g., stainless steel) which can withstand the deformation without detriment to the final tube, and it is preferred for the wall-thickness of the aforesaid region to be reduced, or for the aforesaid region to be provided by an insert, while the tube is straight. By using stainless steel as the material for the tubes, the latter can very conveniently be connected together, after assembly, by welding.

In the case where the aforesaid region is to be provided by an insert, it is preferred for nickel to be used for the purpose (but it will be understood that other suitable metals could be used instead), and the insert can be annealed if necessary before the pressing operation is effected.

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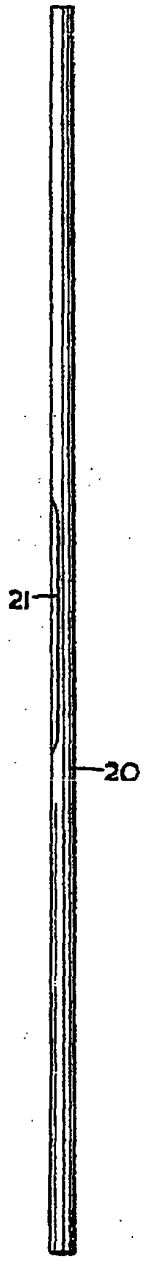


FIG.1.

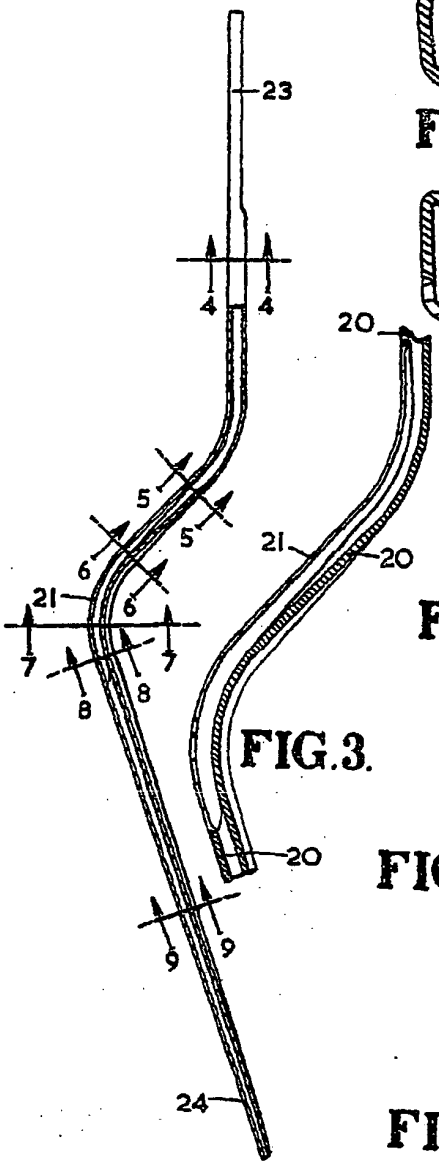


FIG.2.

FIG.3.

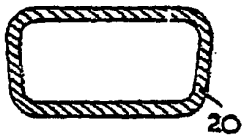


FIG.4.

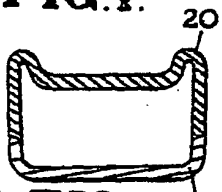


FIG.5.

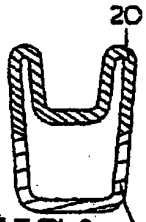


FIG.6.

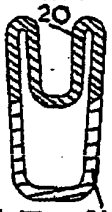


FIG.7.

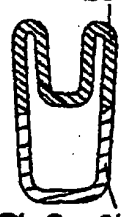


FIG.8.

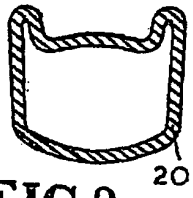
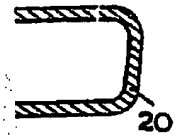


FIG.9.

904,887 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2



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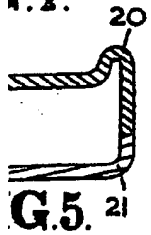
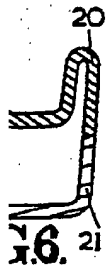


G.5.



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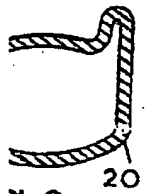

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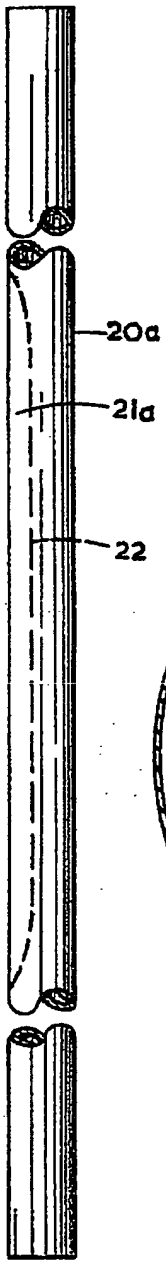

FIG.10.

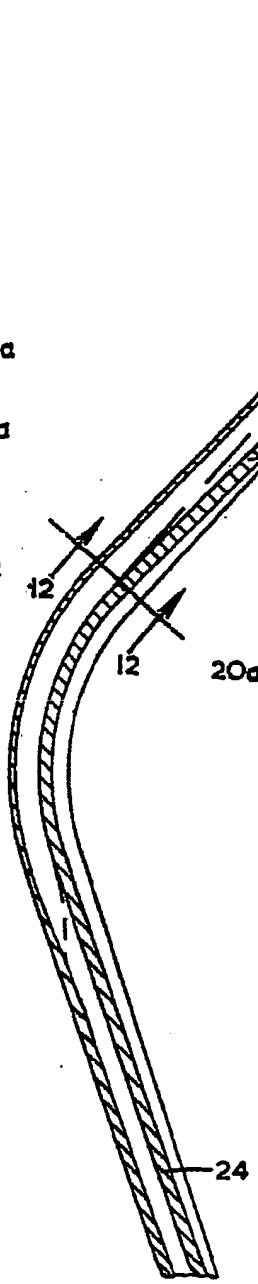

FIG.11.

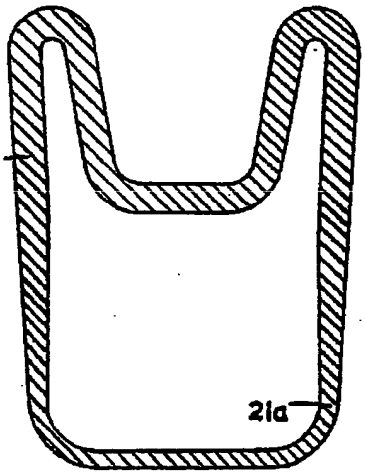

FIG.12.

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SHEETS 1 & 2

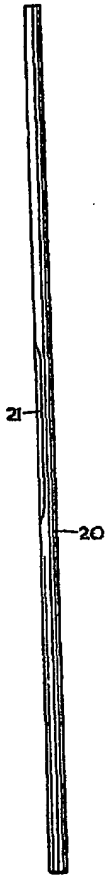


FIG.1.

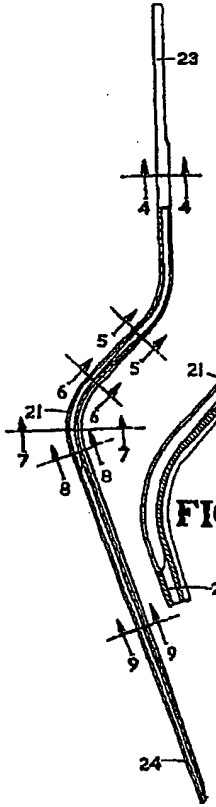
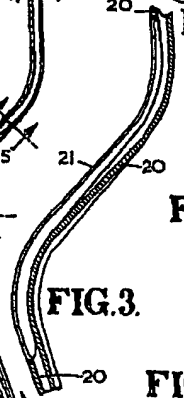


FIG.2.



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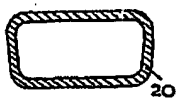
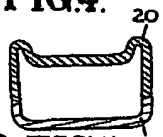


FIG.4.



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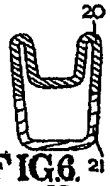


FIG.6.

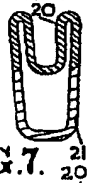
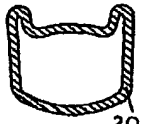


FIG.7.

FIG.8.



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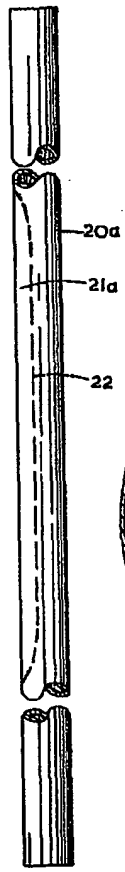

FIG.10.

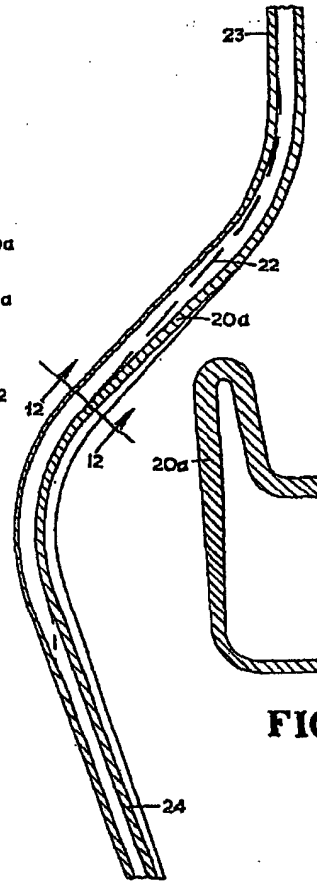

FIG.11.

FIG.12.